CLAIMS

1. A device (124, 500, 600, 700) for ~~producing~~ continuous in-line production of polymer fibers (406, 532, 636, 718A-718C), the device (124, 500, 600, 700) comprising:

at least one nozzle (100, 310, 502, 602) configured to receive a polymer solution and a jet of compressed gas, wherein the at least one nozzle (100, 310, 502, 602) comprises

a body (102, 102a, 102b, 312, 514, 618) having a hollow space (128, 302, 304, 306, 314), an opened first end (104, 316, 516, 620) and a second end (106, 318, 518, 622) opposite to the opened first end (104, 316, 516, 620), a first inlet of the jet of compressed gas (108, 320, 520, 624, 712A-712C) in the second end (106, 318, 518, 622), and at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D), having a diameter 0.6-1.6 mm, being mounted through the second end (106, 318, 518, 622) and the hollow space, (128, 302, 304, 306, 314) wherein the at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D) comprises

an unfixed distal end (112, 324, 524, 628, 708A-708C, 814A-814C, 830A-830C) protruding from the opened first end (104, 316, 516, 620) a proximal end (114, 326, 526, 630) opposite to the unfixed distal end (112, 324, 524, 628, 708A-708C, 814A-814C, 830A-830C), an inlet of the polymer solution (116, 328, 528, 632, 714A-714C, 810A-810D, 832A-832D) at the proximal end (114, 326, 526, 630), and an outlet of the polymer solution (118, 330, 530, 634) at the unfixed distal end (112, 324, 524, 628, 708A-708C, 814A-814C, 830A-830C), wherein the proximal end (114, 326, 526, 630) of the at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D) is fixed to the second end (106, 318,

518, 622) of the at least one nozzle (100, 310, 502, 602) and wherein the first inlet of the jet of compressed gas is formed offset from a nozzle axis and to create a rotating vortex of the jet of compressed gas and cause the unfixed distal end of the tubular fiber spinning needle to revolve or vibrate;

a pump (120, 504, 604) configured to pump the polymer solution through the at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D) of the at least one nozzle (100, 310, 502, 602) with a pressure 0.5 – 2 bar and wherein an injection rate of pumping of the polymer solution to the at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D) is 1 microliter/min – 3.5 ml/min per noozle;

a gas compressor (122, 506, 606) configured to direct the jet of compressed gas into the first inlet of the jet of compressed gas (108, 320, 520, 624, 712A-712C) of the at least one nozzle(100, 310, 502, 602); and

a first moving means of the unfixed distal end (112, 324, 524, 628, 714A-714C, 814A-814C, 830A-830C) of the at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D).

2. The device (124, 500, 600, 700) according to claim 1, wherein the device (124, 500, 600, 700) further comprises two or more nozzles (704A-704C, 804A-804D, 824A-824D) and a spinneret (702, 800, 840) comprising a hollow body (716, 802, 822) having a second inlet of the jet of compressed gas (710, 808, 826), wherein the two or more nozzles (704A-704C, 804A-804D, 824A-824D) are connected to the hollow body (716, 802, 822) by the second end (106, 318, 518, 622) and wherein the gas compressor (122, 506, 606) is configured to direct the jet of compressed gas into the hollow body (716, 802, 822) of the spinneret (702, 800, 840) through the

second inlet of the jet of compressed gas (710, 808, 826) and through the hollow body (716, 802, 822) to the first inlet of the jet of compressed gas (108, 320, 520, 624, 710) of the each nozzle of two or more nozzles (704A-704C, 804A-804D, 824A-824D).

3. The device (124, 500, 600, 700) according to claim 1 or 2, wherein the first moving means of the unfixed distal end (112, 324, 524, 628, 708A-708C, 814A-814C, 830A-830C) of the at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D) is selected from a group comprising a mechanical or electromechanical device moving the unfixed distal end (112, 324, 524, 628, 708A-708C, 814A-814C, 830A-830C) of the at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D), a mechanical or electromechanical device vibrating the at least one nozzle (100, 310, 502, 602) and the first moving means formed by the first inlet of the jet of compressed gas (108, 320, 520, 624, 710) in the second end (106, 318, 518, 622) of the at least one nozzle (100, 310, 502, 602).

4. The device (124, 500, 600, 700) according to any of the preceding claims, wherein the device (124, 500, 600, 700) further comprises a collection unit for collecting the polymer fibers (406, 532, 636, 718A-718C), wherein the collection unit comprises an air permeable fiber collection surface (508, 608, 720) and a suction unit (510, 610, 722) configured to draw an air through the air permeable fiber collection surface (508, 608, 720) and to produce a suction pressure for depositing the polymer fibers (406, 532, 636, 718A-718C) on the air permeable fiber collection surface (508, 608, 720).

5. The device (124, 500, 600, 700) according to any of the preceding claims, wherein the air permeable fiber collection surface (508, 608, 720) further comprises an air permeable fiber collection material.

6. The device (124, 500, 600, 700) according to any of the preceding claims, wherein the collection unit further comprises a heating and solvent evaporation chamber (616) and the air permeable fiber collection surface (508, 608, 720) is a movable air permeable fiber collection surface.

7. The device (124, 500, 600, 700) according to any of the preceding claims, wherein a diameter of the at least one nozzle (100, 310, 502, 602) is 1.5 mm-5.0 mm and a diameter of the at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D) is 0.6 mm - 1.6 mm.

8. The device (124, 500, 600, 700) according to any of the preceding claims, wherein the device further comprises a second moving means (728) of the at least one nozzle (100, 310, 502, 602) to apply at least one movement to the at least one nozzle (100, 310, 502, 602), and wherein the at least one movement is selected from rotating the at least one nozzle (100, 310, 502, 602), moving the at least one nozzle (100, 310, 502, 602) left and right, and moving the at least one nozzle (100, 310, 502, 602) up and down with respect to the air permeable fiber collection surface (508, 608, 720).

9. The device (124, 500, 600, 700) according to any of the preceding claims, wherein the device further comprises a compressed gas heating unit.

10. The device (124, 500, 600, 700) according to any of the preceding claims, wherein the hollow space (128, 302, 304, 306, 314) is an axially symmetric hollow space.

11. A method for ~~producing~~ continuous in-line production of polymer fibers (406, 532, 636, 718A-718C) the method comprising:

- pumping a polymer solution into at least one nozzle (100, 310, 502, 602) through an inlet of the polymer solution (116, 328, 528, 632, 714A-714C, 810A-810D, 832A-832D) of at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D) of the at least one nozzle (100, 310, 502, 602) having a diameter 0.6-1.6 mm with pressure 0.5 – 2 bar and wherein an injection rate of pumping of the polymer solution to the at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D) is 1 microliter/min – 3.5ml/min per nozzle;
- delivering a jet of compressed gas into the at least one nozzle (100, 310, 502, 602) through a first inlet of compressed gas (108, 320, 520, 624, 710), wherein the first inlet of the jet of compressed gas is formed

offset from a nozzle axis and to create a rotating vortex of the jet of compressed gas and cause the unfixed distal end of the tubular fiber spinning needle to revolve or vibrate;

- applying movement to the at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D) by the delivered jet of compressed gas;

- forming a droplet (404) of the polymer solution to a tip of a distal end of the at least one tubular fiber spinning needle (110, 322, 522, 626, 706A-706C, 812A-812D, 828A-828D); and

- obtaining a polymer fiber (406, 532, 636, 718A-718C) from the formed droplet (404), wherein a diameter of the polymer fiber (406, 532, 636, 718A-718C) is 0.~~1~~ 2 - 10 micrometers.

12. The method according to claim 11, wherein the method is performed under conditions, wherein ~~an injection rate of pumping of the polymer solution to the at least one tubular fiber spinning needle is 1 microliter/min - 3.5 ml/min per nozzle;~~ a spinning rate of the polymer fibers (406, 532, 636, 718A-718C) per nozzle is 0.2 - 25 grams per minute; a pressure of

the compressed gas is delivered at 0.2 bar - 2.1 bar; a pressure of pumping the polymer solution into the at least one tubular fiber spinning needle is 0.5 – 2 bar; and a temperature of the compressed gas is 20 – 120 ºC, wherein the compressed gas is selected from a group comprising air, nitrogen, argon, oxygen, carbon dioxide and mixtures thereof.

13. The method according to claim 11 or 12, wherein the polymer solution comprises at least one polymer dissolved in at least one solvent, wherein a concentration of the at least one polymer is 9% - 45% by weight of the at least one solvent, and a viscosity of the polymer solution is 1 millipascal-second – 5000 pascal-second.

14. The method according to claim 13, wherein the at least one polymer is selected from a group of bio-based polymers comprising gelatin, collagen, chitosan, chitin, proteins, silk protein, polylactic acid, polycaprolactones, alginate and algae based polysaccharides, zein, gluten, poly (l-lactic acid), polyethylene oxide, cellulose acetate, poly(lactic-co-glycolic acid), mixtures thereof and compounds derived therefrom or the at least one polymer is selected from a group of synthetic polymers comprising polymethylmethacrylate, polyvinyl alcohol, polystyrene, polyaniline, polyamides, polyacrylonitrile, polyurethanes, styrene-acetonitrile copolymer, natural and synthetic rubbers, mixtures thereof and compounds derived therefrom.

15. The method according to claim 13 or 14, wherein the at least one solvent is selected from a group comprising water, alcohols, ethyl acetate, tetrahydrofuran, acetone, acetic acid, formic acid, toluene, chloroform, dimethylformamide and mixtures thereof.

~~13. A polymer solution for producing polymer fibers comprising at least one polymer dissolved in at least one solvent, wherein a concentration~~

~~of the at least one polymer is 9% - 45% by weight of the at least one solvent, and a viscosity of the polymer solution is 1 millipascal-second – 5000 pascal-second.~~

~~14. A polymer solution according to claim 13, wherein the at least one polymer is selected from a group of bio-based polymers comprising gelatin, collagen, chitosan, chitin, proteins, silk protein, polylactic acid, polycaprolactones, alginate and algae based polysaccharides, zein, gluten, poly (l-lactic acid), polyethylene oxide, cellulose acetate, poly(lactic-co-glycolic acid), mixtures thereof and compounds derived therefrom or the at least one polymer is selected from a group of synthetic polymers comprising polymethylmethacrylate, polyvinyl alcohol, polystyrene, polyaniline, polyamides, polyacrylonitrile, polyurethanes, styrene-acetonitrile copolymer, natural and synthetic rubbers, mixtures thereof and compounds derived therefrom.~~

~~15. A polymer solution according to claim 13 or 14, wherein the at least one solvent is selected from a group comprising water, alcohols, ethyl acetate, tetrahydrofuran, acetone, acetic acid, formic acid, toluene, chloroform, dimethylformamide and mixtures thereof.~~

16. A material comprising polymer fibers <u>(406, 532, 636, 718A-718C),</u> <u>wherein the material has a twisted ribbon type mesh morphology and the fibers are</u> produced by using a method according to <u>any of the</u> claim<u>s</u> 11 <u>- 15</u>~~or 12~~ for making a non-woven filter material, a

leather-like textile, a biomaterial for bone regrowth, a wound care material, a 3D scaffold for cell cultivation and tissue engineering, an electrode material for capacitors~~, ceramic nanofibers, cell-cultured meat~~.